Graduate Student Research Seminar

Spring 2025

Categorizing System Failures in High-Dimensional, Mixed-Uncertainty Simulations Using Numerical Error Bounds

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Advisor: Greg Mocko

Monday, March 24th

3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

The design of complex systems of systems is increasingly reliant on simulation models to predict the behavior and failure points of systems. Simulation models of complex systems are often high-dimensional and stochastic using mixed uncertainty. Mixed uncertainty refers to models where different uncertainty representations are used over the input set – some inputs may be represented as Gaussian distributions, others as bounded intervals, and others as deterministic values. The proposed method for categorizing failures to inform design choices uses Monte Carlo simulation and generates failing sets – the subset of each input set that causes system failure. Comparing the error bounds of the input set and the failing set can be used to categorize failures based on their likelihood and significance to a designer wishing to make design decisions using stochastic simulations. The shape of the failing sets and outputs is dependent on the mathematical formalization of the model, the number of failure modes the model considers, and the uncertainty representation of the inputs. Numerical error bounds are used because failing set distributions and the system performance distribution from mixed-uncertainty Monte Carlo simulations do not necessarily fit a Gaussian distribution. A test case based on US Army ground vehicle mobility test procedures is presented to demonstrate this method.

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